

## **Knife Holder for a Microtome**

### Cross-References Related to Applications

This is a Continuation of International Application PCT/EP99/03175, with an international filing date of May 10, 1999, now abandoned.

### 5 Statement Regarding Federally Sponsored Research and Development

Not applicable.

### Reference to a Microfiche Appendix

Not applicable.

### Background of the Invention

### 10 Field of the Invention

Microtomes are used for the production of thin sections of various specimens from medicine, biology, botany, and the materials research and quality control of technical materials, principally plastics. The production of these thin sections takes place with knives of various shapes and properties. Steel knives of selected tool steels are known, and are produced with various kinds of grinding. In addition to these regrindable knives, so-called disposable blades are widely used; for these, a distinction is principally made between so-called wide band blades and narrow band blades, which are replaced by new ones when their service life is exceeded. Furthermore, glass knives and diamond knives are used for special purposes.

Many knife carriers and knife holders for all kinds of knives are known in microtome technology; they additionally differ in their constitution according to the type of microtome they are provided for. These types are chiefly differentiated as rotary microtomes, in which the specimen is moved in the vertical direction relative to a stationary knife, for section removal;

slide microtomes, in which either the knife holder or the specimen holder is moved in a horizontal direction for section removal; and disk microtomes, in which the specimen is arranged on a disk which rotates relative to a stationary knife, for section removal. Microtomes which are used in microtome cryostats correspond to these said types and differ solely by a rustproof embodiment.

The knife carriers and knife holders have as their main purpose to stably clamp the respective cutting tool, in order to attain the result of cutting in the form of a thin section of, for example, 3  $\mu$ . In addition to a stable clamping, which prevents vibrations of the knife, most knife carriers and knife holders have devices for free angular adjustment between the knife edge and the specimen. Further features of typical knife carriers and knife holders are height adjustment devices for the knife to be clamped, clamp devices for fixing the knife carrier and knife holder on a microtome baseplate or a microtome base frame, and also, in the case of knife carriers and knife holders for cryostatic microtomes, so-called section path devices. Knife carriers and knife holders are denoted hereinafter, for simplification, simply as knife holders.

## Discussion of Relevant Art

When working with microtomes there always exists a danger of cuts to the hand from the microtome knife. Finger guards are therefore frequently provided, and have to be brought into their functional position, in which they cover the knife, in each working pause and in each preliminary operation of clamping the specimen in the specimen holder, or when adjusting the knife. In some known knife holders, the finger guard is arranged pivotably on the knife holder for this purpose. Other finger protection devices are not connected to the knife holder and can be

set freely on the knife. In such cases they are frequently held in their position by means of weak magnets, or are positioned by pins. Furthermore, other finger protection devices consist of sideways displaceable rods or guard plates, which can be displaced so that they cover the middle cutting region of the knife edge during work pauses. The said finger protection devices all have the disadvantage that they offer no protection during operation, that is, when a series of sections are cut on the microtome. Corresponding finger protection devices are described, for example, in U.S. Patent 5,099,735 and in GB Patent 2,238,973.

A knife holder is described in U.S. Patent 4,378,719 with covering elements for the cutting edge of the knife which are stationary relative to the knife; the covering elements only incompletely cover the blade, however. A knife holder with a section straightener, which likewise partially covers the blade, is described in U.S. Patent 5,040,470.

Microtomes with knife holders are respectively described in U.S. Patent 1,925,181 and U.S. Patent 5,161,446, in which the abovementioned disadvantages are avoided. The finger protection devices described there respectively have a cover plate for the knife edge, pivotably arranged on the base body of the knife holder, on the specimen side of the knife. When the specimen holder and the knife come close together, this cover plate is pivoted by means of a driver cam out of its functional position in which it covers the cutting edge of the knife, and thus first releases the cutting edge of the knife directly before the section removal. The cutting edge of the knife remains free, however, after a successful section removal, until the specimen holder has become distanced again from the knife so far that there is no longer any contact between the driver cam and the specimen holder. Therefore these protective devices cannot offer any

effective protection from cutting injuries in this phase of the cutting process. Apart from this, the possibility also exists, when cutting specimens with relatively short dimensions in the direction of the cutting edge of the knife, of a finger inadvertently getting between the specimen and the knife blade when the cutting edge is already exposed, and thus suffering an injury.

## 5 Summary of the Invention

The invention therefore has as its object to provide a knife holder with a guard against cutting injuries which is also effective during the performance of cutting operations and section removal. This object is attained by a knife holder for microtomes having a cutting plane, comprising a knife having a cutting edge, and a blade guard comprising a plate, wherein the plate is arranged on a side of the knife remote from a specimen side and spaced apart from the cutting plane of the side of the cutting edge of the knife. Advantageous configurations of the invention will become apparent from the detailed description.

The knife holder according to the invention has a blade guard constituted as a plate. The plate is then arranged, on the side of the knife remote from the specimen side, spaced apart from the cutting plane of the knife to be received in the knife holder or of the blade to be received in the knife holder, and to the side of the cutting edge.

Such a constitution of the blade guard does not need to be removed for the removal of sections. It is thus fully effective during the removal of sections, and can extend over the whole length of the knife or over the whole length of the knife or blade usually exposed for section removal.

The plate is preferably arranged parallel to the knife surface, spaced from the cutting

plane. The spacing between the cutting plane and the plate is then preferably chosen to be as large as the maximum section thickness which can be set on the microtome. However, the spacing should be at most 2 mm.

The plate preferably consists of a transparent material, for example PMMA, for good observability of section production and a judgment of the removed sections.

In a cutting stroke, the specimen moves with the specimen holder relative to the knife edge and the knife holder. The free spaces and distances between the plate and the specimen moving relatively to it are to be set so that a finger joint cannot get between the moving parts.

In most cases, a gap between the knife edge and the plate is unavoidable, so as to ensure the free space required for a successful section production and section removal. The width of this gap is however to be at most 2.5 mm.

In an advantageous embodiment example of the invention, the plate is arranged pivotably or displaceably on the base member of the knife holder. It is thereby ensured that the blade guard can be brought out of its functional position into a position in which the free access to the specimen is ensured which is necessary for adjustment operations on the specimen. So that finger protection is also ensured in this position, a known finger guard, which can be removed from the cutting edge during the cutting operation, is also to be provided.

In a further advantageous embodiment example of the invention, the pivoting or displacement mechanism for the plate is coupled to a switch or microswitch. This switch can in turn be coupled electrically to a brake or arresting device for the knife slide or the specimen slide of the microtome, such that movement of the knife slide or of the specimen slide is prevented

when the plate is pivoted or displaced out of its functional position covering the cutting edge of the knife. An unintentional operation of the knife slide during adjustment operations on the microtome is thereby avoided.

The coupling of a switch, which is coupled to a pivotable or displaceable blade guard, to a brake or a motorized cutting drive is also useful with blade guard devices constituted in another manner, and represents a separate invention.

In microtomes which in any case already have a motorized cutting drive, the switch can be arranged in the circuit of the motor for the cutting drive. The load circuit of the drive motor is connected such that an operation of the drive motor is only possible when the plate is located in the functional position covering the knife edge of the knife. It is thereby ensured that an erroneous operation of the operating element such as a foot switch, for example, for the motor drive does not lead to an unintentional switching-on of the cutting drive and thereby bring about the danger of an accident. Possible defects of the operating elements or electrical or electronic components can likewise lead to a comparable danger of an accident, since in the case of corresponding faults the cutting drive can switch on in an uncontrolled manner. Interference influences from the exterior can produce a similar effect. The risks brought about by such faults and interference can thus be markedly reduced by the knife holder according to the invention.

#### Brief Description of the Drawings

Details of the invention are explained in greater detail with reference to the embodiment examples shown in the Figures. In detail:

Fig. 1 shows a perspective view of a knife holder according to the invention;

Fig. 2 shows a simplified sectional view through the knife holder in Fig. 1;

Figs. 3a and 3b show principle sketches of a knife holder according to the invention with pivotable (Fig. 3a) or displaceable (Fig. 3b) blade guard;

Fig. 4 shows a section through the mounting of a pivoting mechanism for the blade guard according to the invention;

Fig. 5 shows a section through a traversing microtome with a knife holder according to the invention;

Figs. 6a-6c show circuits relating to the inclusion of the switch coupled to the pivoting mechanism in the circuit of an arresting device for the microtome slide or the circuit of a motor drive for the microtome slide;

Fig. 7a shows a perspective view of a disk microtome with a knife holder according to the invention; and

Fig. 7b shows a sectional view of the disk microtome of Fig. 7a.

#### Detailed Description of Preferred Embodiments

The knife holder in Fig. 1 has an essentially conventional construction with, removably mounted on a microtome base, a base member (1) on which a receiving member (2) for the cutting knife (3) is received, rotatable around the cutting edge of the cutting knife (3) for free angle setting. The free angle set at any given time is fixedly set by means of a clamping mechanism (not shown here) which can be operated by means of a lever (6). To fixedly clamp the knife (3), a clamping plate (4) is provided, with which the knife (3) is in a known manner clamped firmly between the receiving member (2) and the clamping plate (4) by means of a

further clamping mechanism operable by means of a lever (5). The base member (2) has, on the side toward the specimen and in the middle region, a recess in which the specimen to be sectioned can come into contact with the cutting edge of the knife (3) and the specimen can be guided over the knife (3) for section removal. The knife is usually freely accessible precisely in the region of this recess of the receiving member (2), so that a cutting injury can very easily happen to the operator. In order to reduce the risk of such cutting injuries, a pivotable yoke (7) is arranged on the clamping plate (4) and can be pivoted, in the case of mounting and adjusting operations on the microtome or on the specimen, so that the yoke covers the cutting edge of the knife (3). After the conclusion of the adjustment operations and before entering into section removal, this guard yoke (7) must however be pivoted back again into a position in which the knife (3) is accessible to the specimen, since otherwise section removal could not take place.

So far as just described, the knife holder in Fig. 1 corresponds to a conventional knife holder. According to the present invention, a further blade guard is provided on the base member (1) of the knife holder. This blade guard consists of two arms (9a, 9b) which are pivotably arranged at the end sides of the base member (1) and which respectively have a holding jaw (10), with a plate (11) of transparent material connecting the holding jaws (10). The plate (11) preferably consists of PMMA. The plate (11) together with the two holding jaws (10) extends over the whole length of the knife holder, in the direction of the cutting edge of the knife to be received.

As can be gathered from a view with Fig. 2, the plate (11) is arranged, parallel to the cutting plane (14), on the side of the knife carrier remote from the specimen holder (13) and the



specimen (12) received on it, and at the same time, is arranged spaced apart from the knife holder on the side of the cutting edge (3a) of the knife. The plate (11) thus faces the cutting edge of the knife. It is ensured by this arrangement of the plate (11) that section removal can take place even with the plate (11) situated in its operating position in which the plate prevents an unintentional gripping of the knife edge (3a). For this purpose, the plate (11) is spaced apart by a gap (d) from the cutting plane (14). The width of the gap (d) then corresponds to the maximum section thickness which can be set on the microtome. In the cutting direction, a small gap (b) is provided between the cutting edge (3a) of the knife and the edge of the plate (11) toward the knife, with a maximum width chosen such that the joint of a person's finger cannot come into contact with the cutting edge (3a) of the knife. The width of the gap (b) is at most 2.5 mm. This gap width is at the same time sufficient for the section taken from the specimen (12) to be able to slide through this gap between the plate (11) and the back face of the knife (3) and to remain lying on the freely accessible back face of the knife (3).

In the embodiment example according to Fig. 1, the plate (11), and thus the whole blade guard, can be pivoted, by pivoting around the pivot axis of the arms (9a, 9b), out of its functional position into an adjustment position in which the specimen is freely accessible for adjustment operations. This pivotability of the plate (11) is shown schematically in Fig. 3a, the plate (11) in the adjustment position being denoted by (11').

In the embodiment example indicated schematically in Fig. 3b, the plate (11) can be displaced by a linear displacement from its functional position into an adjustment position (11''), in which a free access to the specimen (12) is ensured.

A section through the pivot mounting of the arm (9a) is shown in Fig. 4. The pivoting movement of the arm (9a) is connected to a switch, preferably a microswitch (15), by means of an actuating arm (14). The microswitch (15) is constituted here as a normally open contact, that is, the switch (15) is only closed when the arm (9a) is situated in the pivoting position defined by the functional position of the plate (11).

In the traversing microtome shown in Fig. 5, the specimen holder (13) with the specimen (12) received on it is horizontally, linearly displaceable on a slide (16) relative to the knife holder with the knife (3) received on it. An electromagnetically actuatable brake device (17) is arranged in the microtome base member and can arrest the slide (16) in its position at any given time. This brake (17) is electrically connected to the switch (15) in the pivot joint of the plate (11) of the knife holder such that the brake (17) only releases the slide (16) when the plate (11) is pivoted into its functional position in which it covers the cutting edge of the knife (3). In all other cases, a movement of the slide (16) is locked by the brake (17), so that an unintentional displacement of the slide during adjustment operations on the specimen (12) or on the knife (3) is prevented.

The circuit, not shown in Fig. 5, by means of which the switch (15) on the knife holder is connected to the brake (17) is shown in Fig. 6c. The switch (15) is for this purpose connected in the circuit of a current source (18), in series with the electromagnet which opens the mechanical drive brake. Furthermore, a further switch (24) on the control panel of the microtome, and an emergency stop switch (21), which is embodied as a normally closed contact, are provided in series with the electromagnet (17) which opens the drive brake. Opening one of the switches

(15, 21, 24) effects an immediate arrest of the slide (16). The serial connection with the further switches (21, 24) also enables the arrest of the slide (16) to be effected in the cases in which the blade guard is in its functional position.

The circuit for the motor current of a motorized cutting drive is shown in Fig. 6a. In this circuit also, the switch (15) in the pivot joint of the blade guard is arranged in series in the supply circuit of the motor (20). A switch (19), preferably normally open, for switching the drive motor on, and furthermore an emergency stop switch (21), can be provided here in series in the circuit.

In the embodiment example according to Fig. 6b, the switch (15), together with the start switch (19) on the control panel of the microtome and the emergency stop switch (21), is in the coil circuit of a relay (22). The drive motor for the disk drive (20) is in the load circuit of the relay (22, 23).

Combinations are of course also possible of the embodiment according to Fig. 6c with one according to Fig. 6a or 6b, in that the switch (15) is connected both in the supply circuit of a motor for the disk drive and also in the circuit for an additional brake of the specimen slide or knife slide, so that on opening the switch (15), as well as the drive motor being switched off, and in addition the slide is also arrested in its present position.

A substantial protective effect results from the inclusion of the switch (15) in the circuit of a brake and/or of a motorized cutting drive, since a motor-driven movement of the cutting drive and a danger connected with this is only possible when the blade guard is located in its functional position. In this functional position, however, cutting injuries are precluded, since the cutting edge of the knife is not at all accessible to the operator. The risk of cutting injuries on the

microtome knife is thereby considerably reduced.

In the embodiment example in Fig. 7, the knife holder according to the invention is shown in connection with a disk microtome. This disk microtome consists of a baseplate (30) on which a circular disk (33) for receiving the specimen (32) is arranged by means of a column (31). The disk (33) can be rotated by a motor drive, not shown here. Furthermore, the base portion (34) of the knife holder, with the knife (37) received in it, is arranged on the baseplate (30). The previously described blade guard with the arms (35a, 35b) and the plate (36) connecting the arms is pivotably arranged on the base portion (34) of the knife holder. Cutting injuries on the knife are largely excluded by the knife holder according to the invention in such a disk microtome also, since, by the coupling of the switch connected to the pivoting mechanism of the guard device with the drive motor for the disk (33), a rotation of the disk (33) is only possible when the plate (36) is situated in its functional position covering the knife (37).